QUICK GUIDE

M1026A Diagnostic Tool

Quick Guide

FOR USE OF M1026-10800 WITH THE M1026A ANESTHETIC GAS MODULE

PHILIPS

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Introduction

This chapter contains basic information about the M1026A Diagnostic Tool.

Purpose of the M1026A Diagnostic Tool

Use the M1026A Diagnostic Tool to troubleshoot and service the M1026A Anesthetic Gas Module.

WARNING This software may never be used for patient monitoring! It is not a medical product.

The M1026A Diagnostic Tool was written to fulfill the needs of different versions of Andros Technologies Inc's Model 4700 gas monitor. Therefore it may require more steps to perform a task on the M1026A with this software than it does with an ACMS host monitor.

You may find it more effective to calibrate the M1026A with an ACMS system and use the M1026A Diagnostic Tool software for troubleshooting only, as it offers more detailed subassembly information and a wider range of settings that you can use for isolating a specific failure. Still the software gives you the chance to calibrate the M1026A if no ACMS is available as host.

WARNING After working on the M1026A with the Diagnostic Tool, always perform a cold-start of the device on an ACMS before using it on patients.

Who This Book is For

This book is for Philips trained service personnel with a good understanding of English. They must follow the tasks in this guide very thoroughly, especially the step by step instructions for the common tasks.

Accompanying Documents

This book helps engineers using the M1026A Diagnostic Tool on the Philips M1026A. For detailed instructions on how to use the Diagnostic Tool itself refer to the Model 4700 Diagnostic Software User Guide that is included on the CD that you have received with this software. Related Documents accompany this Quick Guide, providing important additional information.

Table 1 Related Documents

Name	Part#	Published by
Model 4700 Diagnostic Software User Guide	891185-000	Andros Inc.
Agilent M1026A Opt. #A01 Installation and Service Guide	M1026-9000D	Philips Medical Systems
Agilent M1026A Opt. #A02/#A05 Installation and Service Guide	M1026-9000E	Philips Medical Systems

M1026A Diagnostic Tool

This document is valid only for the described revision of the M1026A Diagnostic Tool.

Table 2 Revision History of M1026A Diagnostic Tool

Revision	Date	Description
A	04-Oct-2001	Initial Release, help functionality not implemented yet.

Table 3 File Versions of last M1026A Diagnostic Tool Release

File Name	Size	Modification Date	Revision
diag4700.exe	1.295.360 bytes	20-Mar-2002 11:57:16 AM	B, 3/20/2002
Pegrp32a.dll	1.403.904 bytes	17-Oct-1999 10:24:18 PM	3.0.0.3
diag4700.ini	21 bytes	01-Sep-2001 10:42:30 AM	-

Glossary of Terms

Diag 4700	M1026A Diagnostic Tool
Model 4700 Diagnostic Software	M1026A Diagnostic Tool
CMS	(Philips) Component Monitoring System
ACMS	(Philips) Anesthesia Component Monitoring System
NVRAM	Non-Volatile RAM
host	host monitor that can either be an ACMS or a Laptop/PC running the M1026A Diagnostic Tool
ACK	“Acknowledged” response of the M1026A if a command was accepted
NAK	“Not Acknowledged” response of the M1026A if a command was sent to it that is not allowed during the state of operation it is in.
4710 (head)	IR measurement head
AID (head)	Agent Identification head

Setting up the System

For information about system requirements and how to install the software, refer to the appropriate section in the Model 4700 Diagnostic Software User Guide.

To establish the connection between the computer and the M1026A, use a 9 pin female to 25 pin male RS232 cable that you can order under the part number **24542GCP**.

1 Connect the M1026A to your PC/Laptop with the RS232 cable.

2 Launch the M1026A Diagnostic Tool.

3 Start up the M1026A.

You may need to select the appropriate COM-port in the M1026A Diagnostic Tool. To do this, make your selection in the **Com Port Setup** Item from the **Options** menu. You can access this from the application’s main window.

Communications Protocol

The M1026A receives and transmits data using asynchronous serial RS232 communication. Amongst this data are commands to the M1026A, the measurement data and status information from the M1026A.

M1026A Command Responses

The host system transmits commands to the M1026A as a series of bytes defined by the Host Command Format. The M1026A responds in one of several ways, defined by the ACK Response Format, the NAK Response Format or a “no response”, displayed as Timeout by the M1026A Diagnostic Tool.

Table 4 Response Types of Host Commands to the M1026A

Command Response Type	M1026A Command Response Description
ACK	The command will be executed. The command is correctly formatted, recognized by the M1026A, allowed, the checksum is correct and a system error condition does not exist.
NAK	The command cannot be executed. The NAK response can be caused by a variety of conditions, of which the following are of interest: • M1026A self-test error • zero calibration in progress • zero calibration failure • span calibration in progress • pump state incorrect • self-test in progress • sample line disconnected • not allowed at this time (for example, M1026A is in watchdog sleep mode, occlusion, startup/warmup operating mode, zero calibration failure, no AID feature installed) • M1026A busy (for example, a self-test is in progress, an EEPROM write is in progress, a setup is in progress, a save flowrate is in progress)
No Response	Among the conditions that can result in a “no response” by the M1026A, the following are of interest: • a command was received that met all formatting criteria except that the command code is (a) not valid or (b) not part of the active M1026A command set (see Table 5) • a host system command was received before the previous host system command had been ACK/NAK-responded to

Command Sets

Commands are accepted by the M1026A only if they belong to the currently active command set. There are different command sets of the M1026A, of interest are the following two:

1 standard command set

2 support command set

To enter the support command you have to send a **Setup $E3** command.

Table 5 Command Sets

Command Set	M1026A Command
Standard	Self Test $00
	System ID $05
	Digital O_2 $11
	Zero $1F
	Xmit Error/Status $30, $31, $32
	Miscellaneous Data $50
	Pump Control $62
	Format Control $D7
	Solenoid Control $E2
	Setup Command $E3
	Watchdog Control $E5
	Select Agent $F1 - $F6
	Soft Reset $FE
Support	Reset Span $22
	1-Point Span $23
	2-Point O_2 Span $24 (not used with the M1026A)
	Save Zero $26
	Save Flow Command $E7
	New Pump/Reset Pump Hours $E8

The standard command set is a subset of the support command set. If the M1026A is in support command set it accepts all standard commands as well.

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Common Tasks

This chapter contains important information on how to operate an M1026A with the host software.

Operating Modes

After powering on the M1026A, it is in **startup mode** for two minutes, then it goes into **warmup mode**. After eight minutes and a successful zero calibration, it reaches the **normal operation mode**.

The M1026A has limited capabilities and does not accept all commands sent by the host while it is in **startup** and **warmup mode** - the behavior is comparable to standard operation in combination with an ACMS monitoring system. The different modes are indicated by the Startup, Warmup, and Normal message in the **Operating Mode** display in the main window of the M1026A Diagnostic Tool.

Startup Mode

In startup mode, the device switches valves and flowrates for performing:

- self-test
- calculate ambient pressure
- calculate the O_2 cell offsets

Ignore any error messages the M1026A Diagnostic Tool displays when in this operating mode. Do not try to send any command to the M1026A.

Warmup Mode

In warmup mode, M1026A Diagnostic Tool should not display any errors and it will not accept these commands:

- **1-Point Span $23** commands

Although they will ACK during warmup mode, the use of the following commands is not allowed in this phase of operation:

- **Zero $1F** commands
- **Save Zero $26** commands
- **Setup $E3** command

Data measurement and agent identification accuracy are available to a reduced specification.The M1026A uses zero calibration data stored in the NVRAM of the IR head for calculating gas concentrations.

Normal Operation Mode

You can use the full command set. Some commands require you to first send the **Setup $E3** command to enable the support command set of the M1026A (see the referring section to this command).

Although full measurement accuracy has been reached in this mode. You cannot use calibration commands (such as span calibration and save zero) until the M1026A reaches full thermal stability, 30 minutes after powering on.

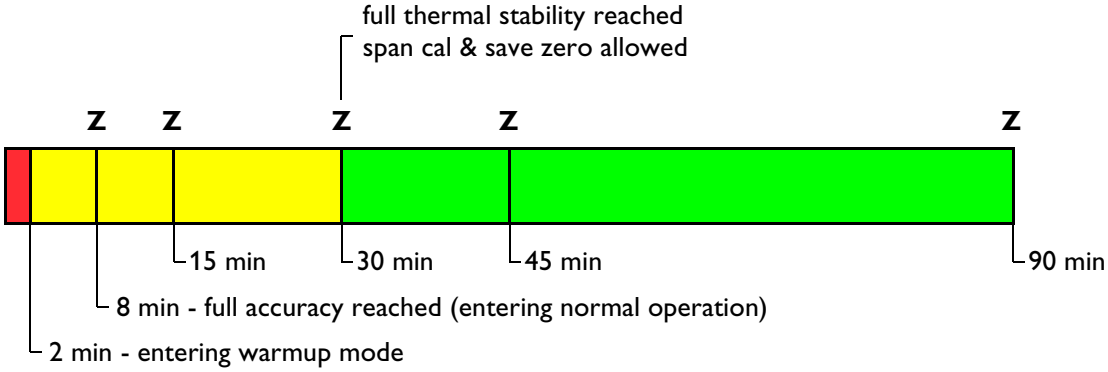
Zero Calibration

To compensate for thermal drift, the M1026A requires a zero calibration after specific time intervals or when certain operating conditions are met. During this zero calibration, all three major measurement assemblies inside the M1026A (O_2 head, Agent ID head and IR-head) are flushed and calibrated with room air.

The M1026A will not start a zero calibration procedure on its own. It sends a zero request to its host monitor (the host can be either an ACMS or a Laptop/PC running the M1026A Diagnostic Tool). The host has to send a zero command to the M1026A containing several parameters before it will carry out this procedure.

The intervals in which the M1026A requests a zero calibration during the first 90 minutes of operation are shown in Figure 1. After this 90 minutes period, it requests a zero calibration every eight hours.

Figure 1 Zero Calibration Request Times



Auto versus Manual Zero

You can set Zero to either **Auto** or **Manual** in the main window of the M1026A Diagnostic Tool.

If Zero is set to **Auto,** the application automatically initiates a zero command as soon as the M1026A requests one.

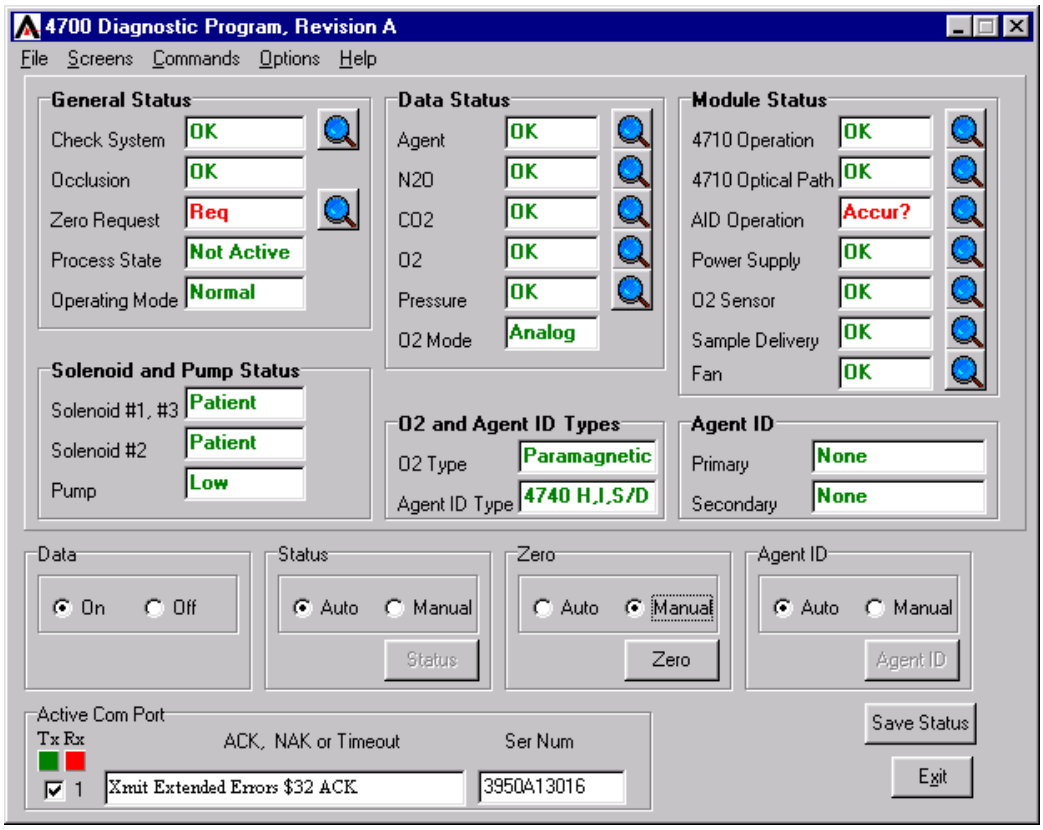
If Zero is set to **Manual,** the application does not send a zero command when M1026A requests one. You must use **Zero $1F** command screen and send the zero command manually as soon as the request appears.

The request for a zero calibration is displayed as a Req in the **Zero Request** field in the main window of the M1026A Diagnostic Tool (see Figure 2).

You must send a zero command manually after:

- span calibration
- flow calibration
- barometric pressure calibration
- repair/parts exchange
- preventive maintenance

Figure 2 Zero Request from the M1026A



Manual Zero Calibration Parameters

You can adjust the options for a manual zero calibration in the **Zero $1F** command screen. You can access this screen two ways. Select either:

- **Zero $1F** from the Commands Menu or
- **Manual** in the Zero section of the main window and press the **Zero** button.

You can adjust three settings in the command window of the zero calibration. Use the default values during a manual zero calibration described in Figure 3.

Figure 3 Parameter Settings for Zero Calibrations

Parameter	Description	Diag4700 automatic values
Purge Time	The time used to flush the 4710 sample cell (IR head and Servomex O2 sensor with room air before zero calibration data is taken). Total Purge Time is 2.0 seconds plus supplied value.	0
Sample Line Purge Time	The time period used to flush the whole system with new patient sample gas before zero calibration is completed. Total Sample Line Purge Time is 2.0 seconds plus supplied value.	0
Flowrate	Servomex O_2 cell flowrate during zero calibration. Two choices can be made: normal (=120ml/min) and high (=200ml/min).	low

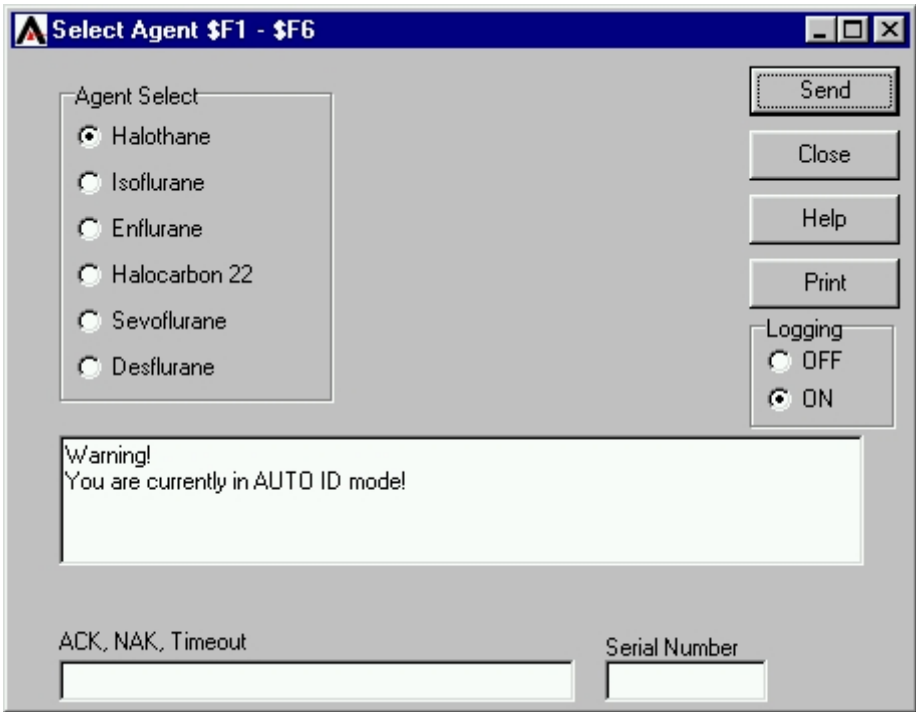
Manually Selecting the Anesthetic Agent

Manually select the anesthetic agent:

- if there is no agent identification head present in the M1026A
- if the Agent ID head of the M1026A cannot determine the agent present (this situation is only occurs during normal operation of the M1026A with an ACMS system)
- before doing a span calibration

To select the agent, enter the **Select Agent $F1 - $F6** command screen. Select it either from the **Commands** menu in the main screen or by switching **Agent ID** to **manual** in the main window and pressing the **Agent ID** button.

Figure 4 Select Agent $F1 - $F6 command screen



3

Service Tasks

This chapter contains important information on how to perform service tasks on the M1026A with the Diagnostic Tool.

Flowrate Check and Adjustment

You can use the **Pump Control $62** command window the M1026A Diagnostic Tool to switch the M1026A to four different pump states:

- Off
- Low
- High
- Purge

CAUTION The M1026A does not use the **High** flowrate during normal operation. Do not switch to this flowrate when doing the flow adjustments.

Follow the appropriate section, depending on whether you are working on an #A01 (Nafion) version or on an #A02/#A05 (watertrap) version of the M1026A.

See the M1026A Installation and Service Guide for instructions on removing the top cover, where to locate the potentiometers R125 and R126 (if you need to adjust flowrates) and for information on the equipment you need to check and adjust flows.

Nafion M1026A Flowrate Check and Adjustment

Always perform a leakage check, described in the M1026A #A01 Installation and Service Guide, before starting with flowrate checks and adjustments. Make sure that a bacterial filter is fitted to the inlet of the M1026A before starting with the flow checks and adjustments.

For #A01 models of the M1026A you need to check two flowrates, in the following order:

1 Total flow in **Purge** mode.

2 Total flow in **Normal** mode.

Table 6 Flowrates of the M1026A #A01

Flowrate	Value	Tolerance
Purge Flow	300 ml/min	+/- 15 ml/min
Normal Flow	120 ml/min	+/- 10 ml/min

To check and adjust the Purge and the Normal flowrate of the M1026A:

Purge Flow

1 Connect the flowmeter to the exhaust of the M1026A.

2 In the **Solenoid Control $E2** command window, open valves to room air by selecting **Both Room Air (sol #1, #2, #3)**[1] and send the command.

3 In the **Pump Control $62** command screen, select the **Purge** flowrate and send the command.

If the measured actual flowrate is outside the tolerance values (see Table 6) you must adjust it; go to step **4**. If the measured actual flowrate is inside the tolerance values, proceed to step **5**.

4 To adjust the **Purge** flowrate, remove the top cover and adjust the potentiometer **R125** on the PC board until you achieve the value you require.

Normal Flow

5 In the **Pump Control $62** command screen, select the **Low** flowrate and send the command.

6 In the **Solenoid Control $E2** command window, close both valves by selecting **Patient Sample** and send the command.

If the measured actual flowrate is outside the tolerance values (see Table 6) you must adjust it; go to step **7**. If the measured actual flowrate is inside the tolerance values, proceed to step **8**.

7 To adjust the **Normal** flowrate, remove the top cover and adjust the potentiometer **R126** on the PC board until you achieve the value you require.

8 If you adjusted any of the flowrates, you must send a **Setup $E3** command and then a **Save Flow Rate $E7** command. The M1026A now goes through different flowrates and stores internal parameters into the NVRAM of the IR-head for each single flow.

To check if the data could be written to NVRAM correctly, confirm that there is no error in the **Check System** Details Screen.

CAUTION For future operation, it is vital to initiate a **Save Flow Rate $E7** command after every flow adjustment! Always do a zero calibration after you complete the flow adjustments.

Watertrap M1026A Flowrate Check and Adjustment

Always perform a leakage check as described in the appropriate M1026A Installation and Service Guide before starting with flowrate checks and adjustments.

For #A02/#A05 models of the M1026A you need to check three flowrates in the following order:

1 Total flow in **Purge** mode.

2 Flow in **measurement path** in **Normal** mode.

3 Total flow in **Normal** mode.

1. There is no #3 solenoid inside the M1026A, please ignore this number.

Table 7 Flowrates of the M1026A #A02/#A05

Flowrate	Value	Tolerance
Total Purge Flow	310 ml/min	+/- 15 ml/min
Measurement Path Flow	120 ml/min	+/- 3 ml/min
Total Normal Flow	150 ml/min	132 ..170 ml/min

To check and adjust the Total Purge, the Measurement Path and the Total Normal flowrate of the M1026A:

Purge Flow

1 Connect the flowmeter to the exhaust of the M1026A

2 In the **Solenoid Control $E2** command window, open valves to room air by selecting **Both Room Air (sol #1, #2, #3)** and send the command.

3 In the **Pump Control $62** command screen, select the **Purge** flowrate and send the command.

If the measured actual flowrate is outside the tolerance values (see Table 7) you must adjust it; go to step **4**. If the measured actual flowrate is inside the tolerance values, proceed to step **5**.

4 To adjust the Purge Flowrate, remove the top cover and adjust the potentiometer **R125** on the PC board until you achieve the value you require.

Measurement Path Flow

5 In the **Pump Control $62** command, screen select the **Low** flowrate and send the command.

6 In the **Solenoid Control $E2** command window, close both valves by selecting **Patient Sample** and send the command.

7 Attach a Flow Split Test Tool to the inlet of the M1026A and connect the flowmeter to the measurement line of this fixture using the attached male Luer Lock.

8 If the measured actual flowrate is outside the tolerance values (see Table 7) you must adjust it; go to step **9**. If the measured actual flowrate is inside the tolerance values, proceed to step **10**.

9 To adjust the Measurement Path Flowrate, remove the top cover and adjust the potentiometer **R126** on the PC board until you achieve the value you require.

Total Flow

10 Connect the flowmeter to the exhaust.

11 In the **Pump Control $62** command screen select the **Low** flowrate and send the command.

12 If the measured actual flowrate is outside the tolerance values (see Table 7), check all the tubing for occlusions (such as kinks and dirt) and replace it if necessary. Repeat the flowrate check. If the measured flowrate is still not within tolerance, replace the Nafion tubing, bacterial filters and flow restrictor in the drainage path of the M1026A (tubings are provided in the PM Kit and the Internal Tubing Kit). Repeat flowrate check.

13 If you adjusted any of the flowrates, you must send a **Setup $E3** command and then a **Save Flow Rate $E7** command. The M1026A now goes through different flowrates and stores internal parameters into the NVRAM of the IR-head for each single flow.

To check if the data could be written to NVRAM correctly, confirm that there is no error in the **Check System** Details Screen.

CAUTION For future operation, it is vital to initiate a **Save Flow Rate $E7** command after every flow adjustment! Always do a zero calibration after you complete the flow adjustments.

Barometric Pressure Check and Calibration

Perform a Barometric Check and Calibration only when the top cover of the M1026A is closed. Electromagnetic interference may affect the measurement.

Table 8 gives you examples of typical barometric pressure values at various altitudes.

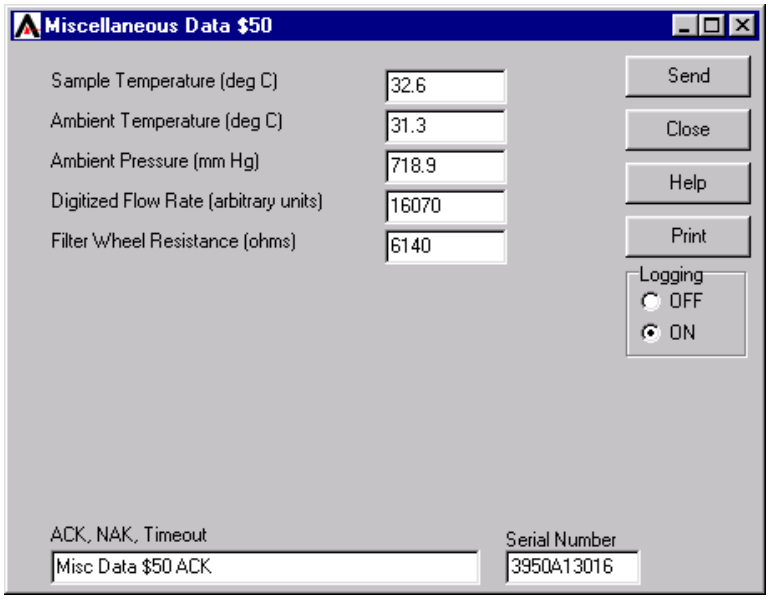
Table 8 Typical Barometric Pressures at various Altitudes

Altitude [m]	Pressure [mmHg]	Altitude [m]	Pressure [mmHg]	Altitude [m]	Pressure [mmHg]
0	760	1100	664	2200	577
100	751	1200	656	2300	570
200	742	1300	648	2400	562
300	733	1400	639	2500	555
400	724	1500	631	2600	548
500	715	1600	623	2700	540
600	707	1700	616	2800	533
700	698	1800	608	2900	526
800	689	1900	600	3000	519
900	681	2000	592		
100	682	2100	585		

If an accurate barometer is not available and the hospital cannot provide you with an accurate value for the current absolute barometric pressure, call the local weather station or airport. Weather stations and airports sometimes provide barometric pressure values that are corrected to sea level. Ensure that the value you are given is valid for the hospital location.

CAUTION The ambient air pressure is measured during zero calibrations when the pump is off and the valves are both switched to room air. Therefore you must initiatie a zero calibration after every pressure calibration before you can check the new pressure value.

Figure 5 Miscellaneous Data $50 window with Ambient Pressure value



Pressure Check

To check the barometric pressure:

1 Initiate a zero calibration with the **Zero $1F** command.

2 To ensusre that the zero calibration is finished, wait until the **Process State** field in the main window of the Dagnostic Tool switches back from Active to Not Active or until the **Process State** field in the **Zero $1F** command window switches back from **In Progress** to blank.

3 Send an **Miscellaneous Data $50** command to the M1026A and check the ambient pressure value that the M1026A returns (see Figure 5).

4 If the ambient pressure value is within the tolerance limits (see Table 9) you do not need to calibrate the the barometric pressure. If it is out of tolerance follow the steps described in the Pressure Calibration section.

Table 9 Barometric Pressure Tolerance Limits

Item	Measured Value Tolerance
barometric pressure	ambient pressure +/- 5 mmHg

Pressure Calibration

Unlike the one-step calibration of the barometric pressure with an ACMS in service mode, the M1026A Diagnostic Tool requires you to do multiple steps on your own. Precisely follow the steps here to calibrate the ambient pressure of the M1026A device:

1 In the **Solenoid Control $E2** command window, open valves to room air by selecting **Both Room Air (sol #1, #2, #3)** and send the command.

2 In the main window Switch Data to **Off** (otherwise the M1026A would not allow the pump to remain switched off).

3 In the **Pump Control $62** command window, switch Pump **Off**.

4 In the **Setup Command $E3** command window "unlock" the M1026A temporarily to bring it into the setup state.

5 In the **Watchdog Control $E5** command window chose **Disable** and send the command.

6 In the **1-Point Span $23** command window, chose the **Pressure** to be calibrated and enter the current ambient pressure into the respective field. Send the command.

The message **1-Point Span $23 ACK** in the command status line of the **1-Point Span $23** command window indicates that the M1026A has accepted the command. Now the **Process State** status line in the **1-Point Span $23** command window should show **In Progress** (see Figure 6). As soon as this message disappears and no error message is visible, the calibration was carried out successfully.

7 To check if the data could be written to NVRAM correctly, confirm that there is no error in the **Check System** Details Screen.

8 To check if the pressure readings now are within the specified limits:

a. In the main window, switch **Data** back to **On**. With a little delay, the pump should start running again.

b. In the **Solenoid Control $E2** command window, close valves again by selecting **Patient Sample** and sending the command.

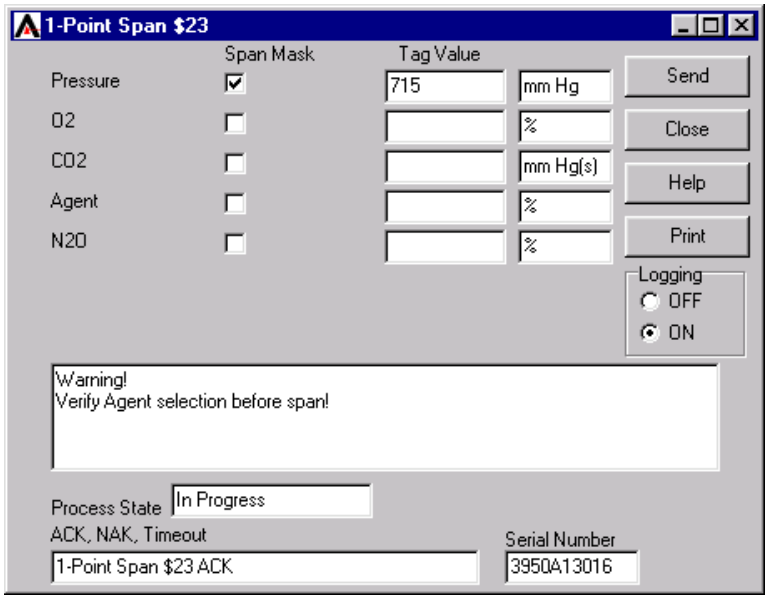
c. In the Watchdog **Control $E5** command window chose **Enable** and send the command.

d. Initiate another zero calibration with the **Zero $1F** command.

e. To ensusre that the zero calibration is finished, wait until the **Process State** field in the main window of the Dagnostic Tool switches back from Active to Not Active or until the **Process State** field in the **Zero $1F** command window switches back from **In Progress** to blank.

f. Use the **Miscellaneous Data $50** command (see Figure 5) to get the new pressure reading and check if it is within the tolerance limits (see Table 9). If the value is within the limits you're done. If it still is not within the valid range, further investigation/troubleshooting is necessary to find the root cause for the wrong reading.

Figure 6 Pressure Calibration in Progress State



Gas Span Calibration

The gas span calibration with the M1026A Diagnostic Tool requires multiple steps. It is easier with an ACMS host monitor. It is described here in case you need to calibrate the M1026A without an ACMS.

Prerequisites

Before performing a span calibration you must first:

- perform a Performance Leakage Check as described in the M1026A Installation and Service Guide
- perform a Diagnostic Check (**Module Status** in the main window of the Diagnostic Tool has to show OK for all modules)
- perform a Flowrate Check
- perform a Zero Calibration Check
- perform a Barometric Pressure Calibration Check
- ensure that there is enough gas in the calibration gas bottle
- check tubing assembly

Settings

Make the following settings in the M1026A Diagnostic Tool:

1 Go to the **Select Agent 4F1 - $F6** command window, either by selecting the entry from the commands menu or by clicking on the **Agent ID** button in the application's main window. Select the used anesthetic agent and send the command. If you are using the M1660A Calibration Gas Mixture you should select **Halocarbon 22** as the anesthetic agent.

2 Go to the **Format Control $D7** command window and make sure that % is selected as unit for all gases. If not, make the necessary adjustments and send the command.

Equipment

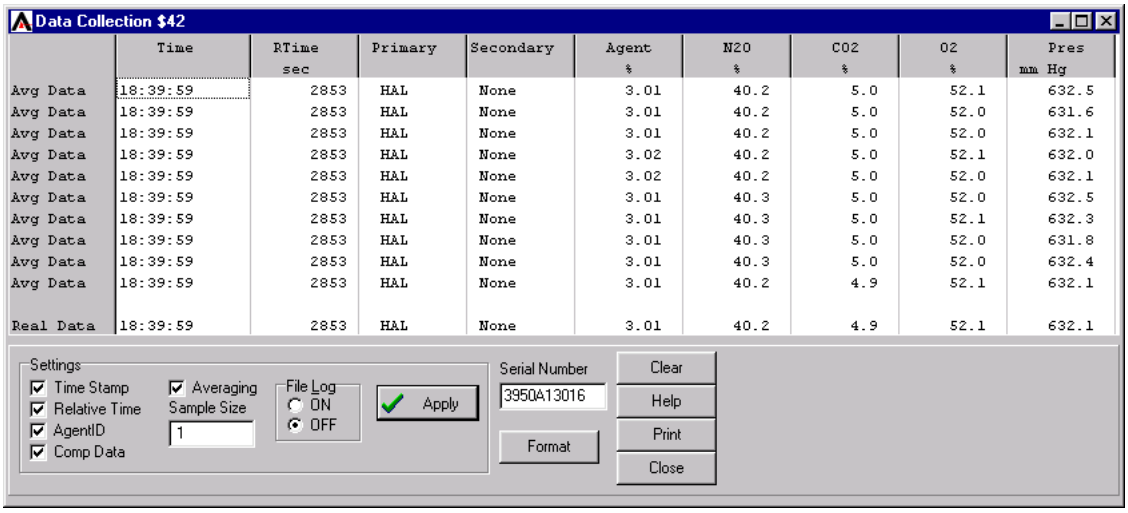
To perform the calibration checks you need:

- calibration gas bottle
- reservoir bag
- sample line

Gas Span Calibration Check

Make a Gas Span Calibration check by activating the **Data Collection $42** screen (see Figure 7). Compare the shown values to the content of your calibration gas (see Table 10) and verify whether the readings are inside the acceptance limits.

Figure 7 The Data Collection $42 screen


Data Collection $42
Time
RTime sec
Primary
Secondary
Agent %
N2O %
CO2 %
O2 %
Pres mm Hg
Avg Data 18:39:59 2853 HAL None 3.01 40.2 5.0 52.1 632.5
Avg Data 18:39:59 2853 HAL None 3.01 40.2 5.0 52.0 631.6
Avg Data 18:39:59 2853 HAL None 3.01 40.2 5.0 52.0 632.1
Avg Data 18:39:59 2853 HAL None 3.02 40.2 5.0 52.1 632.0
Avg Data 18:39:59 2853 HAL None 3.02 40.2 5.0 52.0 632.1
Avg Data 18:39:59 2853 HAL None 3.01 40.3 5.0 52.0 632.5
Avg Data 18:39:59 2853 HAL None 3.01 40.3 5.0 52.1 632.3
Avg Data 18:39:59 2853 HAL None 3.01 40.3 5.0 52.0 631.8
Avg Data 18:39:59 2853 HAL None 3.01 40.3 5.0 52.0 632.4
Avg Data 18:39:59 2853 HAL None 3.01 40.2 4.9 52.1 632.1
Real Data 18:39:59 2853 HAL None 3.01 40.2 4.9 52.1 632.1
Settings
Time Stamp
Relative Time
AgentID
Comp Data
Averaging
Sample Size
1
File Log
ON
OFF
Apply
Serial Number
3950A13016
Format
Clear
Help
Print
Close

CAUTION The M1026A must run for at least 30 minutes before performing a calibration check or a gas span calibration procedure.

Perform span calibration checks only when the top cover is closed. Light and electromagnetic interference can affect the measurements.

1 Connect the reservoir bag to the calibration gas bottle and the sample line that is attached to the M1026A. Do not fill the bag with gas yet.

2 Wait until the pumping action of the M1026A has completely evacuated the reservoir bag. When the reservoir bag is empty, several error messages indicate a system occlusion (see Figure 8).

3 Wait for an additional 10 seconds before opening the spray valve of the calibration gas bottle. Take care that the reservoir bag is not emptied during the following procedures, refill if necessary.

The reservoir bag should not be pressurized.

4 Compare the values that are shown in the **Data Collection $42** Screen (see Figure 7) with the tolerance limits (see Table 10). Calibrate only those gases that are out of the tolerance limits.

Figure 8 Main Window when the reservoir bag is empty

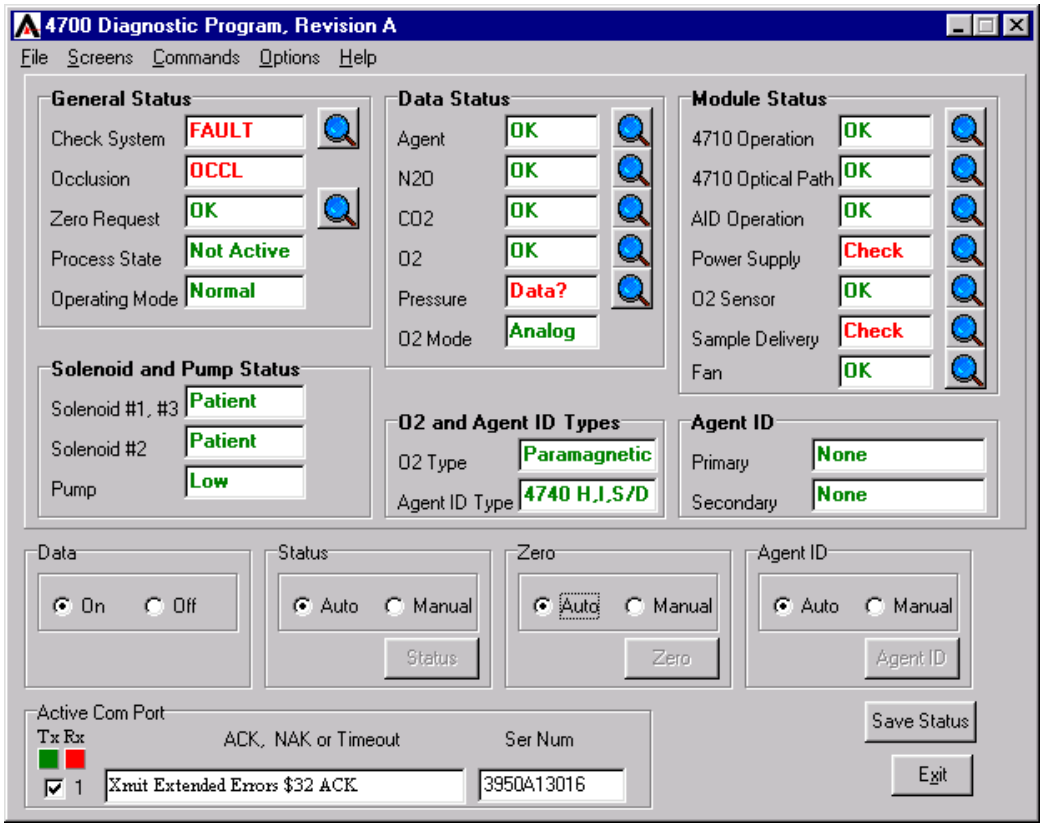


Table 10 Content and Tolerance Limits for the M1660A Calibration Gas Mixture

Gases	Value	Calibration Check Tolerance
O_2	52%	+/- 1.0%
CO_2	5%	+/- 0.1%
N_2O	40%	+/- 2.0%
Halocarbon	3%	+/- 0.1%

Gas Span Calibration Procedure

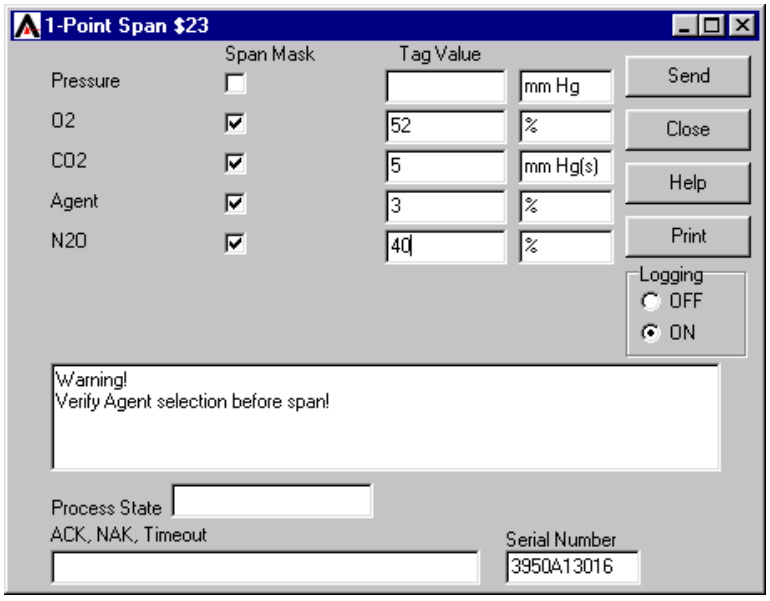
Use the **1-Point Span $23** command screen (see Figure 9) to perform a span calibration. Use the check boxes to determine the gases for which the span calibration should be carried out. The span calibration can be carried out for:

- a single gas

- a selection of some gases
- all available gases

Because the pressure calibration requires different system settings, the **Pressure** check box must not be selected when performing a span calibration!

Figure 9 The Span Calibration Window



In order to be able to store calibration values in the NVRAM, you need to make the following setting in the M1026A Diagnostic Tool:

1 In the Setup **Command $E3** command window "unlock" the M1026A temporarily to bring it into the support command set.

2 In the **1-Point Span $23** command window, place a tick mark in the check box of each gas to be calibrated.

3 Enter the concentration of that specific gas in your calibration gas mixture.

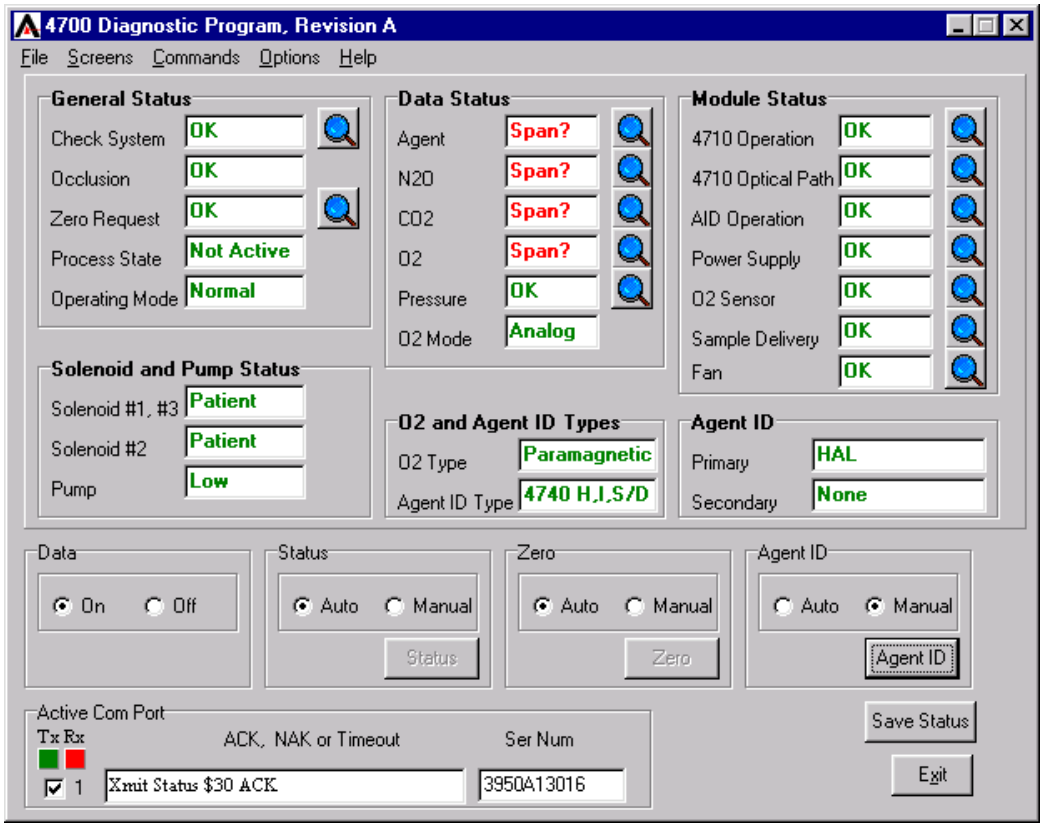
4 Send the command.

5 After sending the **1-Point Span $23** command you should get a **ACK** message in the status line of the command window. During the procedure the **Process State** line in the **1-Point Span $23** command window shows **In Progress**. When the **Process State** line is blank again, the calibration procedure has finished.

6 To check if the calibration was successful, verify that the **Data Status** lines of **Agent**, **N_2O**, **CO_2** and **O_2** show **OK**. in the application's main window. If an error ocurred during the calibration of a specific gas, it will show **Span?** in that line (see Figure 10).

7 To check if the data could be written to NVRAM correctly, confirm that there is no error in the **Check System** Details Screen.

Figure 10 Status Lines after failed span calibration



4

Troubleshooting

This chapter contains information on how to find out more abouth the measurement bench, the pump and the solenoid status of the M1026A. The troubleshooting strategies included in this chapter help you to identify and fix a problem of the M1026A quick and efficiently.

O_2 Cell and Agent ID Types

In the main window of the M1026A Diagnostic Tool there is a field that shows you which O_2 cell is recognized in the gas analyzer. This field can contain:

- Paramagnetic Cell
- No O2

The M1026A can only have a Paramagnetic Cell or No O2. The Fuel Cell type is not used in this gas analyzer.

The M1026A Diagnostic Tool also shows the Agent ID type in the gas analyzer. It can distinguish between:

- 5-Agent ID = 4750 AID
- 3-Agent standard ID = 4740 H, I, E
  identifying Halothane, Isoflurane and Enflurane
- 3-Agent extended ID = 4740 H, I, S/D
  identifying Halothane, Isoflurane and Sevoflurane/Desflurane
- No Agent ID

CAUTION The M1026A Diagnostic Tool was developed for the 5-Agent ID version of the M1026A. While it recognizes 3-Agent ID cells correctly, it cannot select between Sevofluran or Desfluran on a standard 3-Agent ID.

Pump and Solenoid Status

In the main window of the M1026A Diagnostic Tool, a field shows you the pump status. It can show one of the following:

1 Off

2 Low

3 High

4 Purge

The **High** pump mode is not used in the M1026A during monitoring or servicing. It can, however, appear in the main window during a zero calibration or during a saveflow command.

The solenoid status is also shown in the main window of the M1026A Diagnostic Tool. There is no solenoid #3 in the M1026A, please ignore every occurence of this identifier. The status can be:

1 ROOM

2 PATIENT

Measurement Bench

The M1026A Diagnostic Tool provides information about the status of subassemblies using the **Module Status** flags that are shown in the main window of the software. These status flags can be compared to the subassembly information given in the Airway Gas Diagnostic screen availabe in service mode of the ACMS (see Table 11).

Table 11 Module Status Flags vs. ACMS Diagnostic Screen

M1026A Diagnostic Tool flags	ACMS Diagnostic Screen flags
4710 Operation	Meas.Assy
4710 Optical Path	Meas.Optic.Path
AID Operation	Agt-ID.Assy
Power Supply	Power Supply
O_2 Sensor	O2 Assy
Sample Delivery	Pneumatic Sys.
Fan	Operating Temp

Troubleshooting Strategy

The following sections give instructions on how to proceed if any of the modules shows **Check**, **NoData** or **Accur?** in the main window of the M1026A Diagnostic Tool. If more than one subassembly shows this flag, follow this proble- solving hierarchy to isolate and fix the problem most effiecently:

1 Sample Delivery

2 4710 Operation

3 4710 Optical Path

4 O_2 Sensor

5 AID Operation

6 Power Supply

7 Fan

Only if troubleshooting these subassemblies does not solve the problem there may be a problem with the Main PC board, so that you need to exchange it.

Clicking the magnifying symbol beside the **Module Status** flag of any sub-assembly leads you to a **Details Screen** that can give you additional information to help you decide which possible cause is present (see the **Possible Cause** column in the troubleshooting tables).

For information on how to locate/replace subassemblies, how to locate test-points and how to carry out leakage checks refer to the M1026A Installation and Service Guide.

Sample Delivery

Table 12 Sample Delivery Troubleshooting Strategy

Symptom	Possible Cause	Corrective Action
Sample Delivery shows Check	Defective cables (pump, solenoid valves, power supply)	Check the cables for signs of damage or wear. Check the connectors for damaged or loose connections. If any defects are apparent, replace the cable.
	Solenoid or air reference filter problem	Check the solenoid while running a Zero calibration, by feeling whether air is being pulled in at the room air filter. If not, first replace the room air filter. If the problem still persists, replace the solenoid.
	Occluded pneumatics	Check for an occlusion, such as bent or collapsed tubing, or dirty room air filter. Listen for a louder or higher frequency pump noise. This can indicate that the pump is working to compensate for an internal occlusion. Replace watertrap and internal tubing/filters, if necessary.
	Flowrate problem	Perform leakage check as described in the M1026A Installation and Service Guide. If problem still persists, perform flowrate check.
	Flow transducer incorrectly connected to flow restrictor	Check that the transducer ports A and B on the Main PC board are connected to the correct side of the flow restrictor.
	Pump problem	Block the gas inlet and verify that the pump is driven harder to compensate for the reduction in flow. Perform pump test provided in the Preventative Maintenance kit. Caution: The instructions on cleaning apply only to the “old-type” square shaped pump; do not clean the “new type” round pump. If the pump fails the test, replace it.
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective main PC board.	If the checks above do not solve the problem, replace the main PC board.

4710 Operation

Table 13 4710 Operation Troubleshooting Strategy

Symptom	Possible Cause	Corrective Action
4710 Operation shows FAULT or No Data or Accur?	Defective IR measurement assembly head	Do the following IR measurement assembly head checks: • Check whether Service Note M1026A-035/038 applies • Remove the sample cell and visually check it to see if it is contaminated. The inside of the cell should be smooth and shiny. Perform flow and Span gas calibration (in order to store new reference values). • Using a voltmeter, check the IR source voltage as follows: **1** Connect the voltmeter ground to TP1. **2** Measure TP6 voltage. It should be 7.87V ±20mV. **3** If this voltage is within limits, proceed to the next check. If not, adjust the potentiometer R178 to the required value. If the adjustment is not possible, replace the measurement assembly head. **4** Power off. Connect a replacement head with the ribbon cable and reconnect the tubing. Turn power back on and see if the Meas. Assy still shows a problem. If it is gone, replace the head. If the problem persists, continue checking.
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective cables	Check the cables connecting the measurement head and the main PC board for signs of damage or wear. Check the connectors for damaged or loose connections. If any defects are apparent, replace the cable.
	Defective main PC board	If the checks above do not solve the problem, replace the main PC board.

4710 Optical Path

Table 14 4710 Optical Path Troubleshooting Strategy

Symptom	Possible Cause	Corrective Action
4710 Optical Path shows Check	Defective or contaminated sample cell	Remove the sample cell (see M1026A Installation and Service Guide) and visually check it to see if it is contaminated. The inside of the cell should be smooth and shiny. If not, replace the sample cell. Wait after the first automatic zero calibration to see whether the problem disappears. If problems are cleared after warm-up, but were present during warm-up, let the M1026A run for at least 30 minutes after Power On to allow the unit to warm up. Then send a **Save Zero $26** command. This stores the "new" zero calibration values for the next warm-up phase.
	Defective IR measurement assembly head	Carry out the checks for the IR measurement assembly head (see Table 13).
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective main PC board	If the checks above do not solve the problem, replace the main PC board.

O_2 Sensor

Table 15 O2 Sensor Troubleshootin Strategy

Symptom	Possible Cause	Corrective Action
O_2 Sensor shows Check	O_2 jumpers incorrectly set	Check if the O_2 jumpers are correctly set, see M1026A Installation and Service Guide.
	O_2 sensor failed Zero/Span calibration	Perform calibration checks.

Symptom	Possible Cause	Corrective Action
	Defective O_2 sensor	If two solenoids are installed, disconnect cable of solenoid #2 (near O_2 sensor). Ensure that the pump is running on Low flowrate. Note the measured barometric pressure in mmHg displayed in the **Miscellaneous Data $50** screen. Using a voltmeter, check the O_2 sensor voltage as follows: **1** Connect voltmeter ground to TP1. **2** Measure TP8 voltage. 1% O_2 is approximately equal to 10mV. As the O_2 measurement is influenced by the barometric pressure, the correct voltage must be calculated as follows: O_2 concentration of gas in mV multiplied by the measured barometric pressure in mmHg and divided by 760 mmHg. For example, correct calculated voltage for room air (20.9% O_2) and barometric pressure of 720 mmHg is: 209 mV x 720 mmHg / 760 mmHg = 198mV. If the voltage is not within ±10% of calculated value, proceed to adjust O_2 Zero and Span potentiometers in the following order: • **Zero Adjust:** Calculate the correct voltage as described above using the actual room air O_2 concentration and measured barometric pressure. Adjust RV2 potentiometer on the PC Board until the voltmeter reads the calculated voltage ±1mV. You can also use a gas which does not contain O_2 and adjust RV2 potentiometer on the PC Board until the voltmeter reading is 0 mV ±1mV (for location of potentiometers see M1026A Installation and Service Guide). The gas must be applied at the **room air filter**.

Symptom	Possible Cause	Corrective Action
		• **Span Adjust:** Apply Calibration Gas M1660A (containing 52% O_2) to the room air filter (connect the calibration tubing to the open end of the room air filter). Calculate the correct voltage as described above using the specific O_2 concentration and measured barometric pressure. Adjust RV1 until the voltmeter reads the calculated voltage ±10 mV (for location of potentiometers see M1026A Installation and Service Guide). Disconnect the calibration tubing from the room air filter. Reconnect cable of solenoid #2 if it was disconnected. If these adjustments are not successful, check the pneumatic system for leakages (see M1026A Installation and Service Guide) If the problem still persists, replace the O_2 sensor. If any adjustment was necessary, perform a Zero calibration followed by an O_2 Span calibration.
	Defective cables.	Check the cables connecting the O_2 assembly and the main PC board for signs of damage or wear. Check the connectors for damaged or loose connections. If any defects are apparent, replace the cable.
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective main PC board.	If the checks above do not solve the problem, replace the main PC board.

AID Operation

Table 16 AID Operation Troubleshooting strategy

Symptom	Possible Cause	Corrective Action
AID Operation shows FAULT or No Data or Accur?	Defective Agent ID head.	Do the following agent ID head checks. Using a voltmeter, check the IR source voltage at the main PC board as follows: 1 Connect the voltmeter ground to TP1. 2 Measure TP11 voltage. It should be 7.92V ±20mV. 3 If this voltage is within limits, proceed to the next check. If not, adjust the potentiometer R180 to the required value. If adjustment is not possible, replace the Agent-ID head. 4 Power off. Connect a replacement head with the ribbon cable and reconnect tubing. Turn power back on and see if the AID Operation still shows Check. If the message is gone, replace the head. If the problem persists, continue checking. Power Supply Diagnostic Checks
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective cables	Check the cables connecting the measurement head and the main PC board for signs of damage or wear. Check the connectors for damaged or loose connections. If any defects are apparent, replace the cable.
	Defective main PC board	If the checks above do not solve the problem, replace the main PC board.

Power Supply

Table 17 Power Supply Troubleshooting Strategy

Symptom	Possible Cause	Corrective Action
Power Supply shows Check	Defective power supply	Using a voltmeter, check the power supply voltages at the main PC board. The power supply connectors should carry the following voltages: TP14: +12V ±600 mV TP15: +5V ±250 mV TP16: -12V ±600 mV TP17: +12V ±600 mV TP18: Analog Ground If any of the above voltages are out of limits, carry out the checks again while systematically disconnecting the subassemblies (remember to power off the Module before removing cables and subassemblies). If the voltage(s) are still out of limits, replace the power supply.
	Defective cables	Check the cables connecting the measurement head and the main PC board for signs of damage or wear. Check the connectors for damaged or loose connections. If any defects are apparent, replace the cable.
	Defective main PC board	If the checks above do not solve the problem, replace the main PC board.

Fan

Table 18 Fan Troubleshooting Strategy

Symptom	Possible Cause	Corrective Action
Fan shows Check	Defective fan	Check that the fan runs smoothly and check its cable. If necessary, replace fan or cable.
	Insufficient air circulation due to fan working inefficiently	Check the fan aperture for blockages or dust on the fan blade or guard. If necessary, unblock or clean the fan aperture.
	Operating environment for the module falls outside of specified limits	Do not operate the module in such an environment.
	Defective IR measurement assembly head	Carry out the checks for the IR measurement assembly head (see Table 13).
	Defective agent ID head	Carry out the checks for the ID head (see Table 16).
	Defective power supply	Carry out the checks for the power supply (see Table 17).
	Defective main PC board.	If the checks above do not solve the problem, replace the main PC board.

5

Command Reference

This chapter contains information on commands that have not been explained in detail in any of the previous sections.

Self-Test $00 Command

The **Self-Test $00** command initiates an internal test procedure of the M1026A that is a subset of the test procedure the M1026A goes through after a cold-start or a soft reset. During the $00 self-test the RAM read/write capability, the ROM checksums and the RAM constants of both the IR-head and the ID-head are checked.

To start operating and communicating with a host, the M1026A has to pass the initial self-test during start up or reset, so the **Self-Test $00** command is not useful for troubleshooting the M1026A, as all the checks have been passed already.

System ID $05 command

This command returns system identification data to the host among which are the serial number, the Agent ID configuration, the O_2 cell configuration and the pump hours.

Save Zero $26 Command

During the first eight minute of operation, before the first automated zero calibration is initiated, the M1026A uses zero calibration data that has been stored into the NVRAM of the IR assembly. As soon as a 90 minutes zero calibration could be carried out successfully the M1026A stores this data into the NVRAM.

The **Save Zero $26** command immediately stores the most recent zero calibration data in the NVRAM.

You can use this command instead of the Save Zero Software that is used to fix the compatibility problem between Main-PC Board and IR-head that is described in Service Notes **M1026A-035** and **M1026A-038**.

Use this command if the 4710 Optical Path Status shows **Check** during warm-up mode and goes to **OK** after the first automated zero calibration is finished (see Table 14).

CAUTION Allow the M1026A to warm up for at least 30 minutes before sending this command.

Only send this command after a zero calibration was completed successfully.

Miscellaneous Data $50 Command

This command reports the following system data:

- Sample Cell Temperature [°C]
- Ambient Temperature [°C]
- Ambient Pressure [mmHg]
- Digitized Flowrate [arbitrary units] (not useful for any host system)
- Filter Wheel Resistance [Ohms] (not useful for any host system)

The only data that is of interest for troubleshooting/servicing the M1026A is Ambient Pressure that has to be checked during a barometric pressure check/calibration.

Pump Control $62 command

With this command the pump status can be switched between:

- Off
- High
- Low
- Purge

In order to keep the pump switched off Data Reporting has to be switched off in the main window of the M1026A Diagnostic Tool, otherwise the pump will switch back on to Low after a few seconds.

Format Control $D7 Command

This command is used to switch the reporting formats of Agent, N_2O and O_2 between:

- [%]
- [mmHg] = Torr relative to local barometric pressure

The CO_2 format can be chosen out of:

- [%]
- [mmHg] = Torr relative to local barometric pressure
- [mmHg(s)] = Torr relative to sea-level (760 mmHg)
  this format is not used by Philips
- [mmHg(h)] = Torr relative to local barometric pressure and corrected for humidity
  this format is not used by Philips

CAUTION Always make sure that you chose [%] as CO_2 format before performing a gas span calibration.

Solenoid Control $E2 Command

With this command the solenoids can be switched between **Patient Sample** and **Room Air**. Please note that there is no Solenoid #3 in the M1026A, this switch affects the solenoid #1 position only.

Setup $E3 Command

This command is setting the M1026A in a state where it is accepting an extended command set, the so-called **support command set**. This is necessary before commands belonging to the support command set can be initiated (see Table 5).

If you want to return to the standard command set, you have to reset or power-cycle the M1026A.

Watchdog Control $E5 Command

The M1026A is operated in a "**Watchdog Mode**" to reduce unwanted wear on the pump. In this mode the M1026A is expecting a watchdog signal from its host at least once every 60 seconds. If 60 seconds elapse without a receipt of such a signal, the M1026A enters a sleep mode that is commonly known as **Gas Analyzer Standby** when the M1026A is in use with an ACMS system.

The following actions are taken when the M1026A enters the sleep mode:

- the pump is switched off
- all continuous data and status transmission is halted
- any procedure in progress is completed (for example, zero or span calibration)
- the following commands result in a NAK response of the M1026A
  - 1-Point Span $23
  - 2-Point O_2 Span $24 (not used with the M1026A)
  - One-time Data $41 (cannot be sent manually with the M1026A Diagnostic Tool)
  - Continuous Data $42 (cannot be sent manually with the M1026A Diagnostic Tool)
  - Patient Data $4E (cannot be sent manually with the M1026A Diagnostic Tool)
  - Pump Control $62

As soon as the next watchdog signal is sent by the host, the M1026A terminates the sleep mode and normal operation is reestablished.

Disabling the Watchdog Control with the **Watchdog Control $E5** command prevents the M1026A from entering the sleep mode if no watchdog signals are sent anymore. As during barometric pressure calibration continuous data reporting has to be switched off, you have to use this command to disable the watchdog mode, otherwise the M1026A will go into standby.

Save Flow $E7 Command

The **Save Flow $E7** command is storing electrical characteristics of the pump at various flowrates into the NVRAM of the IR-head.

The pump driver circuit inside the M1026A is a servo driven system, always trying to achieve the required flowrate with feedback from the flow sensor. The values that are stored during a Save Flowrate $E7 command are used to detect occlusions or leaks.

New Pump/Reset Pump Hours $E8 Command

After every replacement of the pump inside the M1026A the pump hours have to be set to zero, so that the pump hours can be tracked and the new pump be replaced when it has reached its life-time.

To check if the data could be written to NVRAM correctly, confirm that there is no error in the **Check System** Details Screen.

Soft Reset $FE Command

When the M1026A receives a **Soft Reset $FE** command it performs a complete reset, equivalent to a power-on reset, during which all M1026A functions are reset to defaults.

6

Commands You should not use

This chapter contains commands that are not useful for troubleshooting or servicing the M1026A and should therefore not be used when working on such a unit.

Reset Span $22 Command

The span calibration data of the O_2 cell, the Agent ID head and the IR-head is stored in the NVRAM of the IR-head. The **Reset Span $22** command is re-setting the stored values to factory values.

The calibration data in NVRAM is used during warmup mode and for plausibility checks during future calibration. As the subassemblies' characteristics drift to a certain degree over time, falling back to factory values might bring the M1026A into a state where it is denying any attempt of calibrating the subassemblies. Assuming that the data in the NVRAM is "recent" span calibration data, the new calibration values will not pass the plausibility check as they are too far off the stored ones.

Digital O_2 $11

The **Digital O_2 $11** command causes the M1026A to use a fixed value of 45% of O_2 in the CO_2 correction algorithm. If there is no O_2 cell installed in the M1026A, it automatically switches into this mode. If there is an O_2 cell installed, you should not switch the unit into this mode by sending the command, as the measurement accuracy is better with the actual O_2 value in use for the CO_2 correction.

2-Point O_2 Span $24

The **2-Point O_2 Span $24** command is used for **Fuel Cell** O_2 measurement assemblies that are not in use with the M1026A Anesthetic Gas Module. Only paramagnetic O_2 cells are built in this product. Therefore you do not need this command for working with the M1026A Diagnostic Tool on the M1026A.

Xmit Error/Status $30, $31, $32 Command

You can use this command to retrieve status information about the IR-head, the ID-head, the O_2 cell, the power supply and the pneumatic system from the M1026A if in the Diagnostic Tool main window status reporting is set to manual.

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